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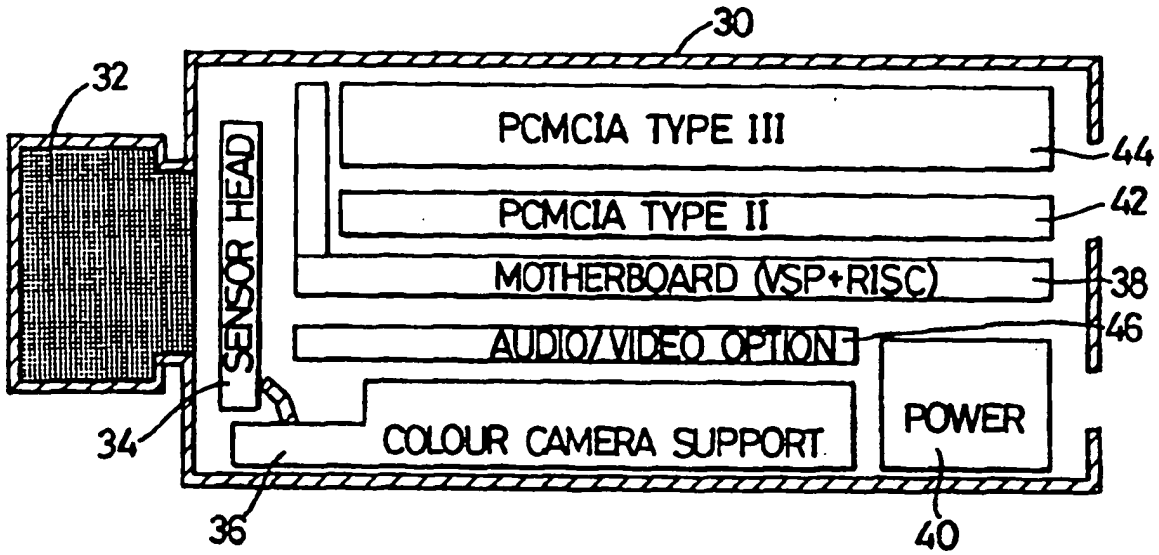
(54) Title: DIGITALLY NETWORKED VIDEO CAMERA



PHYSICAL CONFIGURATION.

(57) Abstract

A self-contained, digitally networked video camera comprises a housing (30) enclosing a camera module having video image sensor means (36) adapted to generate a video signal, signal processing means (38), including a video signal processor (VSP) which receives a digital video signal from the camera module and a multi-tasking RISC processor, adapted to compress and/or analyse said video signal and to output a digital data signal, and digital interface input/output means (42, 44), such as PCMCIA cards adapted to transmit said digital data signal to an external, digital communications network in accordance with a predetermined communications protocol, such as TCP/IP. The camera may be connected directly to a digital communications network, such as a LAN or WAN, for the transmission of compressed, digital video signals and/or associated data directly to host PC's connected to the network. Audio signals may also be processed.

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DIGITALLY NETWORKED VIDEO CAMERA

This invention relates to improvements in video camera apparatus. More particularly, the invention relates to video cameras adapted for direct connection to digital communications networks, and to video cameras which can analyse what they see and/or hear and which can interface directly to digital networks.

In this field it is already known that:

1 Cameras can be interfaced to digital networks via PC's or separate dedicated control units (see, for example, GB-A-2231753; US-A-5237408; WO-A-90/09717).

2 Videophones can interface directly to some digital networks (WAN - Wide Area Networks) but are unable to perform image analysis or audio analysis for the purpose of detecting specific events and moreover cannot interface directly to Local Area Networks (LAN).

3 Analysis of images has been carried out within a camera unit (such systems are available from, for example, VLSI Vision Limited of Edinburgh, UK; Intelligent Camera, Image Inspection Limited of Epsom, UK; and MAPP/LAP, IVP, Linkoping, Sweden)

but never in conjunction with the ability to interface directly to digital networks.

Known cameras and systems of these types have the disadvantages that:

1 It is often impractical and not cost effective to use a PC or separate control unit to allow a camera to interface to LAN/WAN. This is especially true in circumstances where a PC would not usually be present such as in remote surveillance applications: eg construction site monitoring.

2 Existing surveillance cameras, by transmitting video in analogue form, are severely restricted in quality of transmission and recording, automation of surveillance operations, restrictions on network topologies, ability to cross-reference to other events whose occurrence is reported digitally.

3 Existing cameras which can perform image analysis cannot transmit images and the results of analysis over digital networks, thus severely restricting interpretation of results and integration of cameras with existing digital systems.

Use of digital cameras is almost exclusively oriented around PC's and workstations. The requirement for a host PC for capturing and transmitting video is circumvented by this invention. This is achieved by the integration of the hardware and software previously provided by the combination of a camera and separate computer (PC) into a single, stand-alone surveillance camera unit.

The benefits of this are (a) the cost reduction through not requiring a PC to be present and (b) the flexibility achieved by enabling image input to digital networks from locations where PC's cannot be used.

This, combined with the ability to automatically analyse the acquired video and/or audio, within the camera and in real time, allows the automation of a wide range of visual/audio tasks via remote control over digital networks.

In accordance with the present invention there is provided a video camera comprising a housing enclosing video image sensor means adapted to generate a video signal, signal processing means adapted to process said video signal and to output a digital data signal, and digital interface input/output means adapted to transmit said digital data signal to an external, digital communications network in accordance with a predetermined communications protocol.

Preferably, said signal processing means includes a video signal processor (VSP) adapted to perform real-time image compression and/or image analysis on said video signal.

Preferably also, said signal processing means further includes microprocessor means adapted to supervise operation of said VSP and data input/output via said interface means.

Most preferably, said microprocessor means comprises a multi-tasking RISC processor.

Preferably also, said VSP has first memory means associated therewith. Suitably, said first memory means

comprises dynamic random access memory.

Preferably also, said microprocessor means has second memory means associated therewith. Suitably, said second memory means comprises static random access memory.

Preferably also, said communications protocol is TCP/IP.

Preferably also, said interface means comprises at least one PCMCIA card.

Preferably also, the camera further includes audio sensor means, said signal processing means being further adapted to process audio signals generated by said audio sensor means.

While further modifications and improvements may be made without departing from the scope of this invention, the following is a description of one or more examples of the invention, with reference to the accompanying drawings in which:

Fig. 1 is a schematic illustration of a video camera in accordance with the invention connected to a digital network such as a LAN or WAN;

Fig. 2 is a schematic block diagram illustrating the hardware architecture of the camera of Fig. 1;

Fig. 3 is a schematic illustration of the one example of the physical configuration of the camera of Fig. 1; and

Fig. 4 is a schematic block diagram illustrating the software architecture of the camera of Fig. 1.

The invention relates to a camera which can interface directly to digital networks (such as Local Area Networks (LAN's) or Wide Area Networks (WAN's)) and which can carry out real time image compression and analysis. Via the LAN/WAN it can communicate to one or more PC control stations where the compressed video can be decompressed and displayed and the results of the image analysis viewed and/or recorded in a database.

Fig. 1 illustrates an example of such an arrangement, in which one or more cameras 10 are connected directly to the network 12, to which there are also connected one or more host PC's 14. The camera 10 digitises, compresses and analyses video images of a subject 16, and the images and/or associated analysis results are transmitted via the network 12 for display and/or recordal on the host PC 14.

The hardware architecture of the camera 10 is illustrated in block-diagram form in Fig. 2. As seen in Fig. 2, the digitally-networked camera combines a colour camera 18, including an image sensor and, optionally, audio microphone, with a high performance Video Signal Processor (VSP) 20 and a RISC processor 22. The output video/audio signals from the camera 18 are input to the VSP 20, which is connected to the RISC processor 22. The processor 22 is in turn connected to network interface hardware 24. Both the VSP 20 and RISC processor 22 have memory means associated therewith. In this example, dynamic random access memory (DRAM) 26 is connected to the VSP 20 and static random access memory (SRAM) and programmable

read only memory (PROM, preferably Flash EPROM) 28 is connected to the RISC processor 22.

The colour camera 18 may be of the type including an image sensor which directly outputs a digital video signal, or may have an analogue sensor output with separate analogue to digital conversion, or analogue to digital conversion means may be incorporated between an analogue camera and the VSP 20. In any case, the input to the VSP 20 is a digital video signal. The same applies to audio signals from the camera 18, if applicable.

The VSP 20 supports real time image compression and also acts as a highly parallel ALU for real time image analysis. The RISC processor 22 supports a multitasking operating system with built-in networking and communications support, and also supervises the VSP 20. External input/output (i/o) is via the network interface hardware 24; suitably, for example, via two PCMCIA slots, allowing easy interfacing to LAN, WAN, ISDN, wireless communications and mass storage devices. It will be appreciated that digital network interfaces may be provided by means other than PCMCIA-type devices.

The camera also includes a proprietary digital gate array (not shown), which implements bus bridges between the major functional units of the architecture and contributes to the high integration and low cost of the camera unit.

This entire functionality is integrated within a single camera unit. Fig. 3 shows an example of the physical configuration of such a unit. In Fig. 3, a housing 30 supports the camera optics 32 and encloses the image

sensor 34 and associated electronics 36 of the camera 18; a motherboard 38 mounting the VSP 20, RISC processor 22, DRAM 26, SRAM 28 and other associated electronic components; a power supply unit 40; network interface hardware such as type II and type III PCMCIA cards 42, 44; and, possibly, additional, optional audio/video hardware 46. It will be understood that the illustrated physical configuration is given by way of example only and may be varied while still maintaining the essential functionality of the invention.

The RISC processor 22 supervises the execution of image processing and/or compression functions performed by the VSP 20. The RISC processor 22 also supports a real-time operating system (RTOS). The software architecture of the camera is illustrated schematically in Fig 4. This allows genuine multitasking, which is essential in the environment. In parallel, the RISC processor 22 supervises video capture, compression, image processing, audio capture and analysis, and PCMCIA i/o. Context switches must be accomplished within a guaranteed time for this to be effective. Normal multitasking facilities are provided, such as message passing, mailboxes, preemptive/round-robin/time-slice scheduling, interrupt handling, etc.

Various communication protocol stacks may be supported by the RTOS. Preferably, TCP/IP is implemented as the high level network communications protocol. This allows each camera to be assigned a unique internet address and simplifies communications between cameras, and between cameras and host PC's, across multiple heterogeneous networks.

The advantages of the invention and/or the ways in which the disadvantages of previously known arrangements are overcome, include the following.

1. General

The Digitally-networked Camera is designed for real time video capture, compression, analysis and transmission in circumstances where it is either impractical or not cost effective to use a host PC. Since the camera operates stand-alone it can be plugged directly into computer networks or deployed remotely in the field using wireless communications.

2. Security & Surveillance

The digitally-networked camera contains the total functionality required for analogue-networked surveillance systems to migrate to digitally-networked systems. Real-time video/audio compression allows continuous transmission over existing LAN's without significant degradation in LAN performance.

Since the Digitally-networked Camera performs real time image processing, specific events can be detected and reported to personnel. This will dramatically raise the effectiveness of surveillance. The audio option can be used to assist in detection of certain security events including shrieks, breaking of glass, etc.

Thus, the invention allows semi-automation of security surveillance systems. This has the potential to significantly improve the cost-effectiveness of such systems.

3. Traffic monitoring

The Digitally-networked Camera can be programmed to analyse traffic speeds, congestion, vehicle numberplates, etc and can directly report these statistics and/or compressed video to a control centre via a WAN, eg an ISDN/phone line.

4. Video-Conferencing

The Digitally-networked Camera can participate in PC-based video conferences, transmitting compressed video from locations where PC's cannot be used, such as construction sites (wireless LAN) and factory shop floors.

5. Industrial Inspection & Process Control

The invention allows automation of industrial inspection, integrated with existing LAN's for communication of inspection results to controller PC's and control of cameras from PC's.

6. Miscellaneous

The wide range of PCMCIA cards available allows a diverse range of applications to be addressed. For example, to match images captured remotely with the location at which they were captured it is possible to use a GPS receiver card to let the camera get a fix on the position of capture. This might be combined with a cellular comms card to transmit the picture+location immediately back to base.

Improvements and modifications may be incorporated without departing from the scope of the invention as defined in the Claims appended hereto.

Claims

1. A video camera comprising a housing enclosing video image sensor means adapted to generate a video signal, signal processing means adapted to process said video signal and to output a digital data signal, and digital interface input/output means adapted to transmit said digital data signal to an external, digital communications network in accordance with a predetermined communications protocol.

2. A video camera as claimed in Claim 1, wherein said signal processing means includes a video signal processor (VSP) adapted to perform real-time image compression and/or image analysis on said video signal.

3. A video camera as claimed in Claim 2, wherein said signal processing means further includes microprocessor means adapted to supervise operation of said VSP and data input/output via said interface means.

4. A video camera as claimed in Claim 3, wherein said microprocessor means comprises a multi-tasking RISC processor.

5. A video camera as claimed in Claim 2, wherein said VSP has first memory means associated therewith.

6. A video camera as claimed in Claim 5, wherein said first memory means comprises dynamic random access memory.

7. A video camera as claimed in Claim 3, wherein said microprocessor means has second memory means associated therewith.

8. A video camera as claimed in Claim 7, wherein said second memory means comprises static random access memory and programmable read only memory.

9. A video camera as claimed in Claim 1, wherein said communications protocol is TCP/IP.

10. A video camera as claimed in Claim 1, wherein said interface means comprises at least one PCMCIA card.

11. A video camera as claimed in Claim 1, further including audio sensor means, wherein said signal processing means is further adapted to process audio signals generated by said audio sensor means.

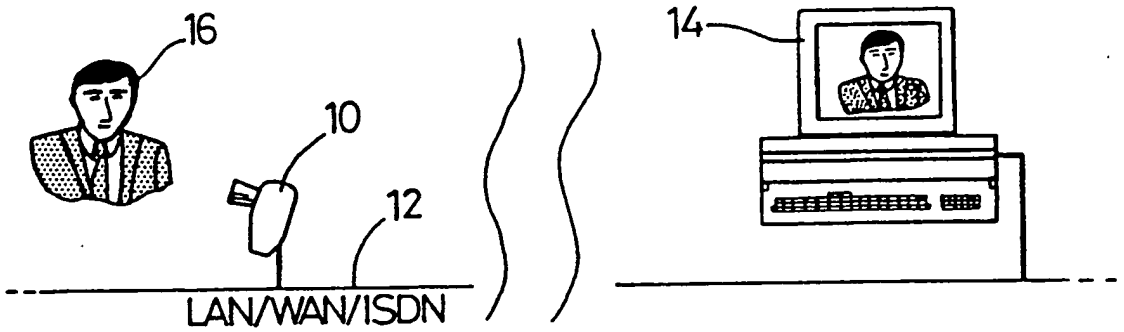

Fig.1 THE CAMERA INTERFACES DIRECTLY TO LAN/WAN AND THEREBY CAN OPERATE UNDER CONTROL OF ONE OR MORE ATTACHED PCs / WORKSTATIONS.

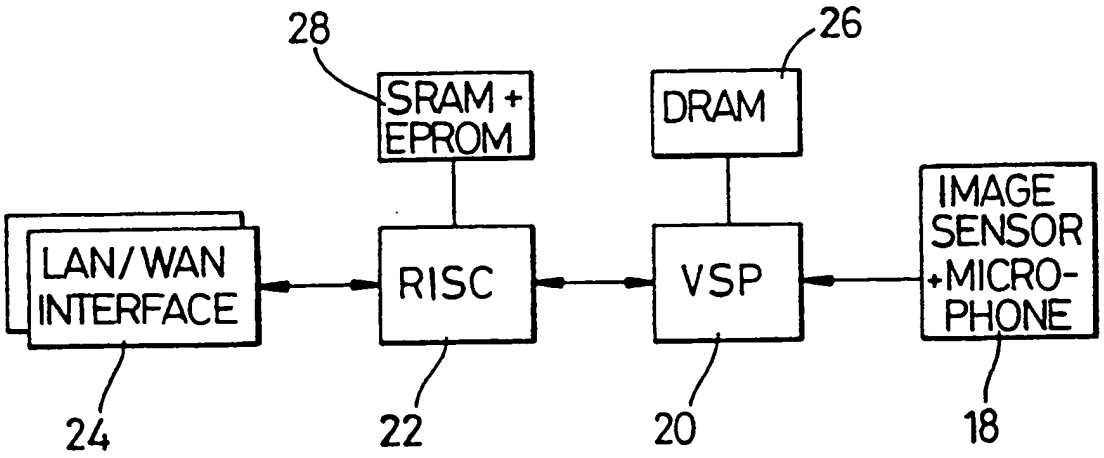

Fig. 2 HARDWARE ARCHITECTURE OF INVENTION ALLOWING CAMERA UNIT TO ATTACH DIRECTLY TO DIGITAL NETWORKS.

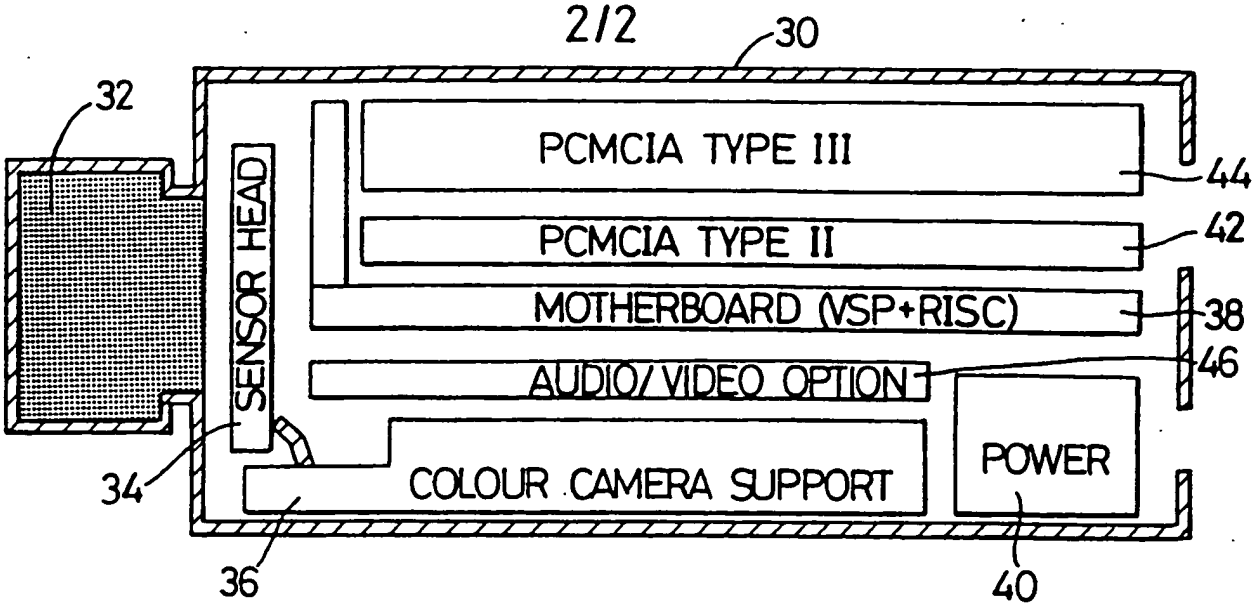

Fig. 3 PHYSICAL CONFIGURATION.

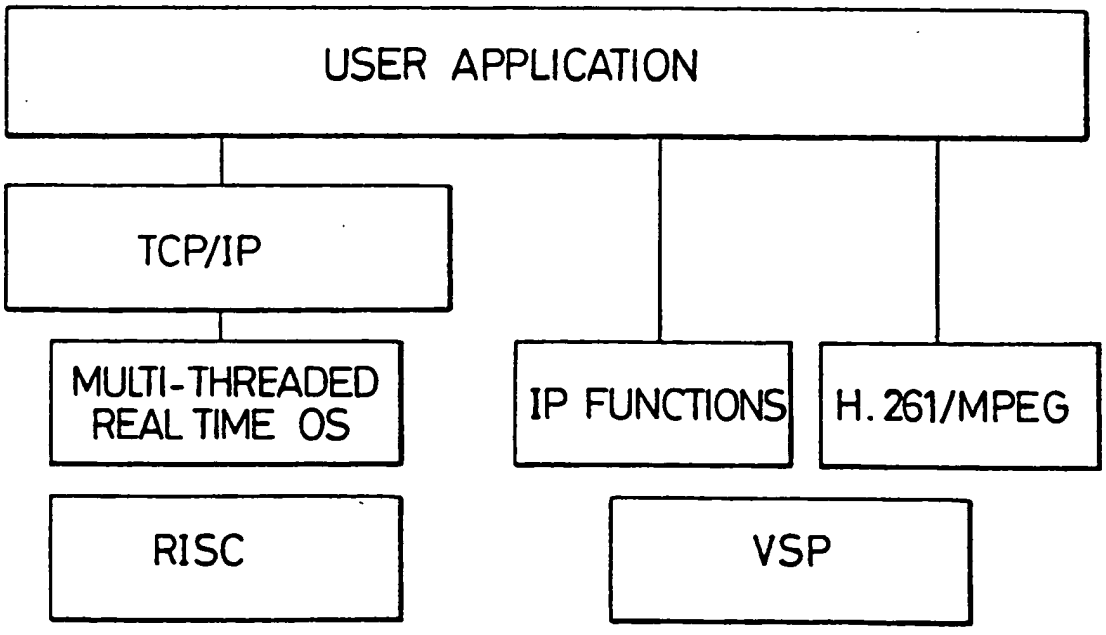

Fig. 4 SOFTWARE ARCHITECTURE OF CAMERA, ALLOWING IMAGE ANALYSIS IN CONJUNCTION WITH IMAGE COMPRESSION AND TRANSMISSION OVER DIGITAL NETWORK.

INTERNATIONAL SEARCH REPORT

Int ional Application No
PCT/GB 95/01626

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 H04N5/232

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 6 H04N

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	PROCEDDINGS OF THE SPIE, vol. 1989, 24 - 24 July 1993 BELLINGHAM, USA, pages 88-102, A. MCLEOD ET AL. 'Applications of intelligent cameras'	1-3,5-8
Y	see page 89, paragraph 1.3 'Integrated systems'; see page 91, paragraph 3.1 ' Modular architecture' to page 94, paragraph 3.9 ' Other modules'; see figure 1	4,9,10

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[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
30 October 1995	10. 11. 95

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+ 31-70) 340-2040, Tx. 31 651 epo nl, Fax (+ 31-70) 340-3016	Wentzel, J

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C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	PROCEEDINGS OF THE SPIE, vol. 2173, 9 - 10 February 1994 BELLINGHAM, USA, pages 178-188, MCCARTHY ET AL. 'High-Performance Image Processing System' see page 186, paragraph 3.2.2. ' Computer Image Processing'; see figure 2 ---	9
X	WO,A,91 07850 (ZONE TECHNOLOGY) 30 May 1991 see page 2, line 14 - page 3, line 22 see page 4, line 5 - page 6, line 1 see page 7, line 1 - line 29 ---	1-3,5-8, 11
Y	ELEKTRONIK, vol. 42, no. 19, 21 September 1993 pages 102-108, 114/115, XP 000395519 MÖLLE S 'KOMPAKT UND FLEXIBEL' see page 104, paragraph 'Vision Controller: Steuerprozessor und Schnittstelle zur Aussenwelt' ---	4
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